RF Exposure Policy Updates

TCB Workshop

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Laboratory Division
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Overview

- 5G NR NSA FR1 (sub-6 GHz) EN-DC UE SAR
- Basic MPE Evaluation and Test Exclusion for Portable Devices $f > 6$ GHz
- Dynamic time-averaging in portable devices
- Updated zoom-scan parameters in SAR measurements
- Vector-measurement-based probe-array SAR systems
- Recent and ongoing exposure evaluation standards activities

5G NR FR1 NSA EN-DC UE SAR Evaluations

5G NR FR1 NSA EN-DC UE SAR 1

- SAR evaluations for 5G NR FR1 NSA EN-DC UE (sub 6 GHz Non-Standalone E-UTRA New Radio Dual Connectivity user equipment) generally may be handled the same as LTE uplink carrier aggregation (UL CA)
- Identify all applicable NSA EN-DC configurations intended for U.S. operations
  - Consistent with e.g., 5.5 of 3GPP TS 38.521-3
  - Similarly as with KDB Pub. 941225 D05A LTE parameters
  - For both NR and LTE operations, identify maximum output power and tune-up tolerances, power reduction or variations among modes and configurations (channel BW, RB allocations, MPR, modulation, sub-carrier spacing, etc.)
- Maximum output power is measured for each NSA EN-DC configuration for applicable test channels

5G NR FR1 NSA EN-DC UE SAR 2

- SAR for EN-DC is required in each exposure condition (highest standalone head test position, body, etc.) and frequency band combination
  - Include test data for both DFT-s-OFDM and CP-OFDM (if both supported by a device)
- Initial NR configurations selected using approach adapted from 5.2 of KDB Pub. 941225 D05
- When the maximum output for EN-DC is less than the standalone NR test configuration (without EN-DC)
  - NR is configured according to the highest standalone SAR configuration tested
  - LTE anchor is configured according to procedures used for power measurement and parameters (BW, RB, etc.) similar to that used for NR

5G NR FR1 NSA EN-DC UE SAR 3

- When the reported SAR for and EN-DC configuration is greater than 1.2 W/kg, EN-DC SAR is also required for other NR-based test channels
- EN-DC SAR is also required for standalone NR configurations greater than 1.2 W/kg when scaled to the EN-DC power level
- To support the test setup and results, SAR reports should contain maximum measured output power, RB allocation, CC offsets, CC channel BWs, MPR, modulation, sub-carrier spacing, duty factor justification. and other relevant information for all EN-DC SAR configurations, including explanations, call box configurations and specific testing limitations or variations, etc.

5G NR FR1 NSA EN-DC UE SAR 4

- PAG requirements for both intra-band and inter-band NSA EN-DC are as follows:
  - Case 1: If the single uplink 1-g SAR values for each band are both less than 0.8 W/kg and the algebraic summation of the 1 g SAR values are less than 1.45 W/kg, additional measurements are not needed; PAG may be waived via pre-TCB KDB inquiry test plan consultation
  - Case 2: If one of the single uplink 1-g SAR values is greater than 0.8 W/kg, instead of algebraically summing the 1-g SAR values, sum up the SAR distributions, similar to the enlarged zoom scan (volume scan) procedures KDB Pub. 865664 D01; PAG is required.
  - Case 3: If the algebraic sum of the 1-g SAR values is greater than 1.45 W/kg, additional measurements might be needed; PAG is required.
    - KDB inquiry is needed for additional testing guidance

5G NR FR1 NSA EN-DC UE SAR 5

- KDB inquiry with test plan and device design details should be submitted by test labs or applicants for operating configurations not covered by the preceding NSA EN-DC interim guidance (e.g. SA, SUL, etc.)
- 5G NR and EN-DC implementation details are needed to identify optimal test approaches
  - The information identified in KDB Pub. 941225 D05A as adapted for 3GPP Rel. 15 5G NR
  - Device design and operating details, including power reduction and other exposure mitigation considerations, etc.
  - As appropriate include test proposal

MPE Basic Evaluation and Test Exclusion Considerations for Portable Devices Above 6 GHz

Portable Device MPE – General

- General guidance for portable devices transmitting at f > 6 GHz has been provided in previous FCC-TCB conference notes (especially since 2017)
- Past TCB notes include that the 5 cm distance of Sec. 2.1093(d) is not applicable for devices that may typically operate at closer spacings
  - Neither is the usual MPE estimate ($S=EIRP/(4 \pi R^2)$) using 5 cm generally applicable
- Portable devices operating above 6 GHz generally remain addressed on case-by-case bases
  - However FCC ID records do include numerous f > 6 GHz portable device MPE evaluations since 2017 using measurements, simulations, and analyses

Portable Device MPE Test Excl.

- Test exclusion justification information for devices not needing other RF exposure testing and reporting have been submitted per KDB Pub. 447498 D01 v06
- Test exclusion based on 1 mW may be used now with the portable device $f > 6$ GHz FCC MPE power density limits
  - Maximum time-averaged conducted power, irrespective of distance from body
  - Analysis exhibit considered for categorically excluded [Sec. 2.1093(c); no PAG] and routine evaluation devices (e.g. Sec. 15.255; KDB inquiry or PAG)
  - Evaluation distance emulating normal use conditions

Portable Device MPE Evaluations

- Planning to continue development on draft KDB pub. on portable device MPE evaluations in coming months
  - Including consideration and adaptation of:
    - Aspects from IEC mmW draft measurement and simulation standards
    - Dynamic time averaging, 4 cm^2 avg. area (freq. based)
    - Approaches used in filings from past few years
    - With typical probe, measurements for some portable devices (e.g. handsets) use probe tip in contact with EUT (2 mm to probe calibration reference point)
  - FCC power density limits are plane-wave equivalent
    - Uniform reference independent of distance, incidence angle, Poynting vector, etc.
    - PWE-PD is the square of the root-mean-square (rms) electric field strength divided by the impedance of free space (377 ohms) (ref. e.g. 21 CFR Sec. 1030.10)

Status of Dynamic Time-Averaging in Portable Devices

Dynamic Time-Averaging 1

- One time-averaging approach that had previously been used with WWAN in a tablet device has been extended and adapted for use with $f >$ 6 GHz portable devices and MPE power density
  - 4 seconds averaging time is used in the 24 GHz to 42 GHz band (per Interim Guidance of Oct. 2018 FCC-TCB conference notes), versus 100 seconds for below 3 GHz
  - Power control by the time-averaging scheme supports some test reductions across mmW EUT multiple beam-patterns
  - Extended algorithm validation test approaches include
    - time-varying Tx power, call disconnect and re-establish; technology/band handover; operating configuration change; antenna or beam switching; change from SAR-predominant to SAR+PD predominant

Dynamic Time-Averaging 2

- Another time-averaging approach was recently used for WWAN in specific laptops
  - The example time-averaging operation is independent of specific host products
    - other than a few basic host-manufacturer set control parameters
  - For this example method, algorithm validation test approaches include: range of control parameters; time varying power control test sequences; drop connection; technology/band handover

Dynamic Time-Averaging 3

- Planning to continue draft KDB pub. development in coming months, considering:
  - Other dynamic time-averaging methods remain subject to case-by-case review (e.g. for WLAN modes), via pre-testing and pre-TCB KDB inquiries
  - PAG re-use may be considered for some device types and time-averaging methods
  - Methods to verify look-back and moving average, etc.
  - TX factor method of draft IEC 62209-1528 may not be generally applicable
    - Unclear that algorithm functionality and validity is dynamically exercised
    - Unclear if worst-case is identified for all combinations of sampling interval, averaging time, power control cycle, etc.
  - Development continuing (in 62209-1528 maintenance WG) for draft IEC Technical Report (TR) on time-averaging algorithm validations and associated EUT SAR measurements

SAR Measurement Zoom-Scan Procedure Changes per Amendment 1 to IEC 62209-2

SAR Zoom-Scan Update 1

- IEC 62209-2:2010/AMD1 published in May 2019
  - Specifies conditions where successively higher-resolution zoom-scan measurements may be needed for some DUTs
  - important with close capacitive-coupling type antennas within a few mm from phantom
- Associated update of KDB Pub. 865664 to be prepared
- Procedure of amendment should be used now
  - Date for required-use and transition period will be established later

SAR Zoom-Scan Update 2

- Initial SAR measurement performed using tabulated zoom-scan parameters in KDB Pub. 865664 D01 v01r04
- Unless the following criteria are met, zoom-scan measurement shall be successively repeated using smaller increments, at 2 mm or less from phantom surface
  - maximum 1 g SAR < 0.1 W/kg, OR
  - both of the following are met:
    - shortest transverse distances d_x and d_y between SAR peak location and -3 dB points shall be larger than Δx_{Zoom} and Δy_{Zoom}, respectively
    - at the SAR peak location, the ratio of SAR values from the first two z-axis points is $\leq$ 30 %

865664 Zoom Scan Summary

				f ≤ 3 GHz	3 GHz < f ≤ 6 GHz
1	Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
2	Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
3		graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
4			$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5 ·$\Delta z_{Zoom}(n-1)$ mm	
5	Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
	* The asterisk table-footnote is per KDB Pub. 865664 D01 v01r04. NOTE For uniformity purposes the integer frequency increments of rows 1 to 3 and 5 apply, rather than the corresponding variable and fixed parameters given in IEC 62209-1:2016 and IEC 62209-2:2010/AMD1:2019.				

Vector-Measurement-Based Probe-Array Systems for SAR Measurements

VMBPAS SAR Measurements 1

- FCC review and assessment of appropriate validation and verification requirements and associated device test methods is continuing towards facilitating use of vector-measurement-based probe-array systems (VMBPAS) for SAR measurement
- Along with updates to validation procedures, measurement uncertainties, etc., leading to the final IEC 62209-3:2019, VMBPAS generally have also evolved in the past few years
- Further comparison and interlaboratory test data using latest measurement system versions with typical modern devices generally remains needed and requested

VMBPAS SAR Measurements 2

- Planning to continue development of a draft KDB publication in coming months
- Including consideration and adaptation of:
  - Aspects from IEC 62209-3:2019
  - Next stage of data acceptance for certification applications based on Fast SAR Procedure A (FSPA) of IEC 62209-1528(:2020)
    - FSPA of IEC 62209-1528 involves e.g. more test frequencies when using VMBPAS compared to conventional scanned-probe SAR systems

RF Exposure Standards
Recent and Ongoing Activities

Exposure Standards Projects 1

- IEC 62209-1528 SAR measurements
  - Final voting draft (FDIS) circulation expected 2019; pub. could be 2Q 2020
    - Combines, with numerous updates: IEC 62209-1:2016, IEC 62209-2:2010 and AMD1:2019, IEEE Std 1528-2013
      - Informally known as Unified Draft
    - Freq. range 4 MHz to 10 GHz; test reductions and fast SAR, proximity sensor method update, measurement uncertainties, limited provisions for vector-based probe-array systems, etc.
    - Work is ongoing in the WG on supplemental documents (tech. reports) for test software validations, exposure time-averaging measurements, wideband signals, etc.
- As with preceding versions of 62209 and 1528, selected topics and procedures from IEC 62209-1528(:2020) may be adapted into RF exposure KDB pubs., rather than adopting documents entirely

Exposure Standards Projects 2

- IEC 63195-x: 6-300 GHz power density
  - IEC 63195-1 measurements
  - IEC 63195-2 (fka 62704-5) numerical simulations
  - Both are joint development with IEEE (parallel balloting, etc.)
  - Enquiry and final balloting remain
    - pub. might be by early 2021
- IEC 63184 wireless power transfer
  - 1 kHz to 30 MHz; includes high-power vehicle chargers; use for e.g. consumer Qi type devices TBD
  - IEEE joint development just started; commenting and voting stages remain
    - mid 2021 might be soonest

Exposure Standards Projects 3

- IEC 6-- (# tbd) Radiative WPT (TC 106 WG9)
  - Document in early WG stage
  - Near-region max.-exposure evaluation using field reconstruction of array-antenna source
- IEEE P1528.7 IoT exposure evaluations (SCC39-ICES TC34)
  - Guide to available exposure evaluation methods and exclusion criteria
  - Considering general guidance for some multi-device scenarios

Published Standards

- Other projects and documents
  - IEC base station WG – handled by OET EMC Div.
  - ICES TC95 limits and associated documents – generally handled by OET EMC Div.
  - Various ITU-R RF exposure projects, also various WPT activities – FCC OET mostly only monitoring
- IEC 62209-2:2010/AMD1:2019
  - Amended SAR measurement zoom-scan step-size requirements – info in preceding section
- IEC 62209-3:2019 vector measurement-based probe-array system SAR measurements
  - See preceding section